Framework for Countries Evaluating Gas-to-Power Pathways

Goal 2: Achieving Energy Security

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Key messages

- Some lower- and middle-income countries will need gas to achieve energy security, at least in the near term. But too much dependence on gas for energy can destabilize a country's economy, energy systems and, ultimately, the lives of its people.
- Energy security requires government officials to correctly predict energy demand. For gas, this is an especially difficult task. Getting it wrong can have high costs, from electricity shortages to wasted public revenues.
- Countries should be realistic about whether they can produce enough gas to fuel power plants for decades to come. Lenders and private energy companies are investing less in new gas extraction. Some countries are also running out of cheap gas, and a switch to extracting higher-cost reserves could force them to increase fossil fuel subsidies or leave consumers to pay more for electricity.
- Governments should, as much as possible, not support deals to import gas. Relying on foreign gas ties a country's energy system to forces and events outside its control. In the worst cases, this can send shockwaves through economies and upend people's daily lives.
- Policymakers and electricity users in gas-producing countries need to fully consider solar and wind as alternatives to gas power, and right-size gas plans accordingly. Both solar and wind have their own challenges, but compared to gas, they can offer lower risks and growing advantages for achieving energy security.

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Overview of this module

Goal 2

Achieving Energy Security

This second part of NRGI's gas-to-power framework interrogates the claim that producing and burning more gas will allow a country to achieve energy security.

It spotlights two big decisions:

- Whether governments and energy companies should try to extract more of a country's own gas for domestic use, and if so, how much.
- Whether governments and energy companies should build more infrastructure to transport, burn or otherwise consume gas, and if so, how much.

Use of gas for electricity generation is the focus, though much of the content also applies to other domestic uses (e.g., industry, heating, cooking).

The module provides background on domestic gas use in lower- and middle-income gas-producing countries, then explores two key challenges that any country wanting to use gas for energy security will have to face: 1) estimating demand for gas, and 2) supplying the gas. For each challenge, it poses some critical questions that stakeholders should ask decision-makers.

Who actually makes these decisions varies by country, and can include heads of state, cabinet and ministerial officials, energy sector regulators, officials at state-owned utilities or other energy companies, parliamentarians, and a range private sector actors.

The module presents some case study-based scenarios of what can go wrong when a country mishandles these two key challenges (without suggesting that relying on gas for energy security will always have negative impacts). It also briefly compares solar and wind power's potential role in energy security with gas.

Common claim 2

"Producing and burning more gas for power will allow our country to achieve energy security."

Background

In Africa, Asia and Latin America, the governments of many lower- and middle-income gas producing countries want to invest more in gas for energy security. Their plans include exploiting more of their gas reserves, importing gas and building new gas power plants. When government officials say they want to use gas for "energy security," they usually have one or more of five common goals in mind:

1 Sufficient energy supply

Ensuring the country has enough energy to meet demand.

2 Uninterrupted energy supply

Avoiding sudden shortages in supply—e.g., those caused by local or foreign violent conflict or political instability, or from other power sources like renewables that cannot consistently produce electricity.

3 Lower energy sector costs

Making energy cheaper for households and businesses and reducing the energy sector's toll on public finances and the economy.

4 Stable energy prices

Protecting consumers and the economy against volatile international energy prices.

5 Energy sovereignty

Insulating domestic energy choices from foreign interests, rules and norms.

Some countries will need gas to achieve energy security, at least for a while. If a country has already built domestic gas infrastructure, it cannot suddenly switch it all off without risking energy shortages. Contracts, laws, economics, and a range of problems with decision-making can lock countries into using existing infrastructure (for more on this point, see NRGI's Gas-to-Power Framework Module 1). Energy transitions also don't happen overnight. Building a new energy system takes huge amounts of capital, human effort, mindset change and time.

Stakeholders should not accept on faith, however, that more investment in gas will bring energy security. Use of the term "energy security" can shut down or confuse debate, blocking serious consideration of the issues. Continuing to invest in and build large amounts of gas infrastructure, whether for extraction or domestic energy supply, can also be a bad choice, for two main reasons. First, some plans simply will not be possible, often because of factors outside the country's control, like a lack of investment by private energy companies and foreign public or private lenders. Others will have hidden socio-economic, political or environmental costs, as the examples in this module illustrate.

In the worst cases, depending on gas for "energy security" can actually make a country's economy and energy systems—and ultimately, the lives of its people—more unstable. Just because a country has reserves of gas doesn't mean gas is the best fuel, especially if the government, private companies and electricity users can invest in alternatives to gas power, such as solar or wind. Both solar and wind come with their own challenges, but compared to gas, they can offer lower risks and growing advantages for achieving energy security. As such, right-sizing the amount of gas used to pursue energy security is critical.

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Considerations and questions

Estimating domestic demand for gas is a complex challenge. Getting it wrong can be costly

How much gas a country will need over time depends on many hard-to-know factors. These include population growth; the growth and structure of the economy, such as the goods and services it produces; changing household energy consumption habits; and the future prices of gas and other commodities that are made with gas. Some governments also struggle to collect enough data to make good projections, especially when different parts of the government—e.g., ministries of industry, energy, petroleum—do not share information with one another.

Uncertainty about the pace of the global energy transition, including the spread of alternatives, makes it even harder for government officials to predict gas demand. Existing worldwide and regional forecasts vary widely, and in the past analysts have often underestimated how fast countries can incorporate new technologies like renewables into their energy mixes.

Gas demand projections for a single country can therefore vary greatly. In Tanzania, for example, the government's Natural Gas Utilisation Master Plan forecasted demand in 2020-2040 to be nearly three times what the International Energy Agency projected demand in its Stated Policies Scenario.

Getting demand numbers wrong can be costly. If a government underestimates demand, the country could face a gas shortage, which can have a range of negative impacts on households, businesses in other sectors of the economy, and public institutions like schools and health centers.

An unexpected gas surplus can be just as serious. If a government contracts to buy more gas than the country can use, its state-owned utilities or other entities can be forced to pay costly penalties, as happened in Ghana. Some governments, faced with gluts of locally produced gas, choose to subsidize consumer gas prices to stimulate demand and avoid penalties. But this move, in addition to being expensive and inefficient, can push a country from gas surplus to shortage if consumption increases too much or too quickly. And once such subsidies are in place, they can be politically hard to roll back, as governments in countries like Malaysia, Indonesia and Argentina have learned.

Officials need to make projections for gas demand as realistic and evidence based as possible

Faced with so much uncertainty, ministries and other government agencies should stress test plans and policies using multiple scenarios, and then model the implications of each. Otherwise, politicians can tout ambitious, best-case plans that underestimate the challenges and risks of investing more in gas.

An important first step in developing good projections is establishing a clear understanding of the different ways that gas is currently being used in the country and the economics of each use. This includes whether different consumers are benefiting from subsidies and whether demand would be less without this support. Then, when turning to the future, officials should wrestle with and explain some basic variables when planning:

Gas' changing role in the power mix

Historically, gas mostly provided baseload generation, but as more renewables are added to the grid, it will be more effective as a "peaker"—providing power when renewable generation drops or demand is high.

This requires different technologies (for example, open cycle rather than combined cycle gas turbines), regulatory frameworks and contractual arrangements. This also means plants will need less gas to run. Officials should plan how gas power and renewables will complement, not compete with, each other over time. For more on the different possible roles of gas in a country's power mix, see NRGI's Gas-to-Power Framework Module 1.

Approach to clean cooking and heating

Some countries are looking to depend more on liquified petroleum gas (LPG), a byproduct of crude oil refining or oil and gas extraction. LPG can provide businesses and households with a somewhat cleaner alternative to biomass and other dirty, time-consuming fuels, but its widespread adoption requires significant policy and financial support from governments. Electric cooking, which does not require LPG, will become increasingly feasible and beneficial for many countries over time. Similar considerations apply to heating, whether that is fueled by gas or LPG.

Viability of other industries using gas as feedstock

Many industries that use gas, such as fertilizer, petrochemical, cement, glass or plastics production, require low gas prices given the competitiveness of imports. Countries like Trinidad and Tobago and Nigeria have been able to displace foreign fertilizer imports mainly because domestic producers use cheap associated gas. In contrast, Mozambique's plans to build fertilizer and gas-to-liquid plants were shelved because the country's deepwater gas would be too expensive as a fuel.

Time required to build infrastructure

Coordinating the construction of a vast array of infrastructure required to move gas to power plants, homes and businesses is an immense challenge. The government in Ghana had to delay taking gas for the domestic market on two separate occasions due to delays in constructing pipelines.

Governments do not need to tackle these complexities on their own. If a government publishes its projections along with the underlying assumptions, actors such as researchers, academics and civil society organizations can help calibrate them with their own data sources, tools and perspectives. Unfortunately, transparency is often limited. Despite Senegal's large domestic gas use ambitions, for example, key government planning documents, such as a gas master plan and least cost electricity generation plan, are not in the public domain.

Countries need to examine whether producing more gas for energy security is affordable, necessary, or even possible

Politicians in gas-producing countries often underestimate the challenges of extracting new gas—especially now, as the world is beginning to move away from fossil fuels. They also overstate the extent to which more gas can fill unmet domestic energy demand, and how affordable it will be.

Here are some considerations to keep in mind when scrutinizing plans for further domestic gas extraction:

Politicians must be realistic about whether private energy companies will invest in new gas extraction for domestic use

Many countries need private oil and gas company partners to help develop their gas reserves. This is especially true of deepwater gas—only about a dozen, mainly Western companies worldwide can produce it. As the global energy transition gathers momentum, privately owned energy companies are becoming increasingly selective about which new gas extraction projects they take on. Meanwhile, many national oil companies say they want to focus more on gas extraction, but it isn't clear how many have the capital or know-how to fill the gaps private operators are leaving.

Stakeholders should ask:

Does the new extraction fit with company investment goals? At least four trends in private energy company decision-making reduce the chances they will invest in new upstream gas projects. Companies are:

- Choosing projects that are cheaper and can start sooner.
- Choosing projects in already developed basins, not frontier areas that require more expensive, risky exploration.
- Looking for projects with lower emissions, in response to pressure from governments, investors and customers.
- Investing less in extraction and more on delivering returns to their shareholders.

Worldwide, new investment in gas extraction projects that serve both export and domestic markets has been declining for almost a decade, despite a slight rebound in 2022 [Source: Rystad data].

Will domestic supply of gas depend on whether the country also exports oil or gas? In many gas-producing countries, gas's viability as a fuel for domestic energy depends on ties to foreign energy markets. There are three common scenarios:

1) The gas is associated (i.e., produced at the same time, and from the same well, as oil). If companies cannot make a profit extracting the oil—frequently, for export—they won't extract the gas. Or, even if they extract the oil, they often reinject, vent or flare much of the associated gas.
2) The cost of producing the gas is high. More costly extraction projects (especially deepwater projects) may need higher export prices and greater market certainty to be viable. Worldwide, about half of all upstream gas projects approved over the last five years have been export-focused. In Africa, over 80 percent of new gas reserves are in countries (e.g., Mozambique, Senegal, Tanzania) where authorities have earmarked most future production for export as LNG.
3) The government has the choice to export the gas or use it domestically. Countries that can turn their gas into LNG often prioritize exports, to get the higher revenues and foreign exchange. In Nigeria, gas extraction companies sell over 80% of what they produce to Nigeria Liquified Natural Gas, which exports LNG to Europe and elsewhere, despite huge unmet electricity demand at home.

Governments should be transparent about how much gas new extraction would deliver, and for how long

Production from new gas fields often peaks early and declines quickly, sometimes by more than 50 percent within the first few years. This does not align well with domestic gas infrastructure like power plants, which require stable supplies of gas over decades. The companies extracting the gas can adjust production to better match domestic demand, but this usually makes the gas more expensive. And when gas output drops but domestic demand for it does not, the country may be forced to import gas, as has happened in mature gas producers such as Argentina, Colombia, Indonesia and Malaysia.

Energy sector officials and consumers need to interrogate how affordable the new gas production will be

The price of gas is the biggest variable in the overall cost of operating a gas power plant. Gas can be a relatively cheap fuel—but not always. Other technologies like solar or wind can be (or become) cheaper, and the prices of domestically produced gas can change over time, if not as dramatically as imported gas prices.

Here are some factors that affect prices:

Onshore vs. offshore production

Offshore gas tends to be more expensive to produce, especially if it is in deep waters. In Colombia, gas from Gorgon and Uchuva, two deepwater deposits currently under exploration, likely would cost 2-3 times more than the country's onshore production, which is declining (NRGI calculations based on Rystad data).

Associated vs. non-associated gas

Producers of non-associated gas tend to demand higher prices, partly because they have no oil to sell. The Ghanaian government negotiated free access to associated gas production but is paying about $8 per mmBtu for non-associated gas.

Extractive companies demanding expensive export-linked prices

If a private energy company weighing whether to invest in an upstream gas project would rather export the gas, it may link the price for domestic supply to export markets. One example of this is LNG netback pricing, by which a company prices domestic gas as if it had exported as LNG, minus the cost of liquefying the gas and transporting it to market. This can increase the average price—though not necessarily, if global prices decline in the coming decades as the energy transition accelerates. Linking domestic prices with exports is likely to make prices more volatile.

Legal and/or fiscal regime for gas

If a country decides to require extractive companies to pay more taxes, royalties or other duties, the companies will attempt to recoup this through higher gas prices.

High, volatile gas prices increase the need and political pressure for subsidies, both for sales of gas and other commodities made with gas. Many countries are already subsidizing gas in ways that are costly and inefficient. Across Africa, only 20 percent of the gas consumed is sold based on the actual cost of supply. For more on risks and costs of subsidizing gas, see the section on gas imports, below.

Officials should ask whether gas extraction companies are already producing, but not using, the amount of extra gas the country needs

Some countries are already extracting and then losing or deferring some or all the gas they will need to meet future domestic demand. This can happen through gas flaring and venting, uncontrolled leaks from gas infrastructure, or reinjecting unwanted gas back into the ground. In Nigeria, flared gas alone has exceeded gas supplied to the domestic market for much of the past two decades (though the situation has improved recently).

Countries should assess whether they can harness more of the gas they extract now before green lighting new production. The techniques for capturing much of this wasted gas are well-known and cost-effective, and small-scale gas utilization technologies have matured significantly in terms of applicability and cost. Indeed, some countries have already successfully captured and commercialized large volumes of wasted gas. Between 2012 and 2022, Colombia cut the flaring intensity of production (i.e., the amount of gas flared per barrel of oil produced) by 69 percent. It also reduced the re-injection of gas from more than 80 percent of gas volumes to about 50 percent, with this gas supplying the domestic market instead.

Significant government effort is required to achieve such results, though, especially since companies will not always agree to change their production practices without pressure. Key government actions include:

Implement new rules about gas production

These could include regulations that prohibit routine flaring and venting, or that require gas development plans to specify how associated gas will be used.

Improve measurement of venting and flaring activity and monitoring of leaks

This includes requiring that companies report emissions from gas infrastructure using a consistent framework and verifying the results through use of third-party satellite data.

Change fiscal burdens on companies

This could include both imposing new penalties for emissions (possibly applying the International Monetary Fund's innovative proposal to base penalties on assumed emission rates, with the burden of proof to demonstrate lower rates falling on the companies, to address potential concerns around reporting compliance or unsubstantiated disputes of government estimates) or exempting companies from certain obligations, like import duty exemptions for the necessary equipment.

Governments should do everything they can to avoid tying their constituents to imported gas

Not every deal to import gas will undermine a country's energy security. But relying on gas imports exposes a country's energy system to many forces and events outside its control. This can have serious socioeconomic consequences when the costs of importing gas rise, or when there is a shortage of imported gas.

The experiences of Bangladesh, Pakistan and the Philippines are instructive cautionary tales. All three countries had become dependent on gas by building significant domestic gas infrastructure (e.g., power plants, industrial facilities that used gas, gas-fired vehicles), and all were relying more on LNG imports as their own gas production declined. Then in 2022, after Russia's illegal full-scale invasion of Ukraine, European Union countries bought up LNG supplies that would otherwise have gone to Asia. For Bangladesh, Pakistan and the Philippines, the resulting LNG shortage and record prices led to closed power plants and factories; skyrocketing electricity costs; weaker local currencies and foreign exchange shortages; costly public debt; high inflation; millions of lost jobs; and a return to dirtier, dangerous fuel sources like coal and private generators, among other harms. For more on the risks and costs of dependence on gas imports, see NRGI's "The Risks of Dependence on Gas Imports." Analyzing the energy security implications of gas imports is a complex, context-specific task.

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Baseline considerations include:

Energy sector officials need to weigh the differing risks of piped gas and LNG

Countries can either import liquified gas by ship, as LNG, or in dry form, through a cross-border pipeline. The two options can have different energy security implications and risks. While each country's situation is unique, key considerations, organized by the five common goals of energy security, include:

1. Sufficient energy supply

LNG imports can be better for countries that need flexibility—for instance, because short-term domestic gas demand fluctuates or long-term demand is uncertain. Piped gas can provide regular long-term supply of stable volumes—if the supplying country delivers on its commitments.

2. Uninterrupted energy supply

Here the choice between LNG and piped gas turns partly on the type of supply threat a country faces:

- **Falling domestic production.** Compared to pipelines, governments can more quickly build and more easily finance LNG import facilities, though some run years behind schedule, as happened in Ghana and the Philippines.
- **Interruptions caused by foreign violent conflict or political instability**. Unrest in other countries or regions can affect supplies of both piped gas and LNG. For piped gas, unrest in a country that supplies or hosts the pipeline can be disruptive to end users. Unrest anywhere in the world can disrupt the supply of LNG since it is a globally traded commodity.
- **Domestic insurrection or conflict.** Armed groups sometimes attack gas pipelines, which are long, valuable and hard to police, as seen in Nigeria's Niger Delta.
- **Regional or global gas shortage.** Gas production shortfalls elsewhere generally do not affect pipeline imports as much as imports of LNG (though there are exceptions). Competition for LNG during shortages is fierce, and wealthier countries with more cash and diplomatic muscle have the advantage in buying up limited supplies.

3. Lower energy sector costs

LNG sale prices are higher than piped gas in many markets, though there are exceptions. In terms of infrastructure costs, LNG import facilities can be cheaper to build than new gas pipelines, especially if the line must stretch over long distances. Officials and investors should also scrutinize the full climate costs of the two options, case by case. Pipelines can lock a country into emitting methane and other dangerous pollutants for longer because they run for longer than LNG import terminals (50+ years versus 10-15 years). But the LNG supply chain requires extra steps like liquification, ship transport and regasification that emit more gases.

4. Stable energy prices

Compared to pipeline imports, relying on foreign LNG can leave a country much more exposed to volatile world energy prices. LNG is a globally traded commodity, and prices are more tied to—and affected by—events abroad that the importing country cannot control. These can include changes in foreign supply, demand, market prices, legal and contract terms, transport costs, investment decisions, security and weather. In August 2023, European spot LNG prices rose 40 percent in one day over fears that workers at Australian liquification plants would strike. Historically, deliveries of LNG to the EU and Asia have been the most subject to volatile prices. LNG traded in the Americas has been cheaper and more stable, but spot prices can still swing by 200 to 300 percent within a few months.

5. Energy sovereignty

Because piped gas and LNG are sold across borders, both can be weaponized for different geopolitical goals. As the Europe 2022 example showed, localized or regional disputes can have worldwide impacts. LNG can be more vulnerable to such shocks because of its greater links to world markets. Buying piped gas from a neighbor can be hard if there are tensions or bad political histories.

Potential gas importers should consider the tradeoffs of "term" versus "spot" deals

Countries can buy gas 1) under contracts that guarantee supplies for months or years (called "term" sales), 2) one batch at a time (called "spot" sales), or 3) through a mix of spot and term sales. Spot and term imports carry differing degrees and types of risk that decision-makers should assess up front:

Risk comparison of term versus spot gas imports

Scenario	Term	Spot
Prices for imported gas suddenly increase	Lower risk, because term prices are usually fixed or at least less linked to events outside the buyer country.	High risk, because spot prices change constantly in response to many factors outside the buyer country's control.
World gas prices fall, but country cannot take advantage, must keep paying more for imports	Medium-high risk, depending on whether term contract prices are linked to larger price benchmarks or can be renegotiated.	Possibly lower risk than for term sales if the country can negotiate advanta-geous spot deals.
Country must pay for gas it doesn't need in times of lower demand	Medium-high risk, depending on contract terms and other reasons. Term buyers of gas usually commit to buying a specific amount over the life of the contract. Ability to reschedule deliveries of gas exists but has limits.	Lower risk, because the country can buy small volumes of gas at a time rather than being locked into an agreed amount.
Country cannot get enough gas because of gas supply/shortage issues elsewhere	Possibly lower risk, if the country's term suppliers are not the source of the shortfall and they honor their obligations.	Higher risk, if other LNG users buy up available spot deals first. Lower risk, if the country can successfully use spot deals to cover the shortfall.

Alternatives to gas: How do renewables compare on energy security?

Renewable energy sources like solar and wind are not a panacea for the difficulties countries face in pursuing energy security through gas use. Solar and wind can face similar challenges to gas power, as well as their own unique obstacles. They also cannot presently provide everything gas can, such as for feedstock for making ammonia, methanol, fertilizers, plastics and petrochemicals; or heat for industrial processes like manufacturing cement, processing minerals, or producing iron, steel and other metals.

Compared to gas power, however, solar and wind can offer real and growing advantages to a country chasing energy security. For example:

1. Sufficient energy supply

Solar and wind farms can start generating power more quickly to address unmet electricity demand. Their average construction times are shorter than for gas power plants, and there is no need to build new fuel supply infrastructure like pipelines since wind and sunshine are free and available on site. Solar and wind projects are increasingly attracting more investment capital than gas, meaning they could be easier to build overall. Renewables are still hard to finance in lower- and middle-income countries, but the overall trend is toward more access to capital, not less, as is the case with gas power. (For more on the challenges and opportunities of financing gas and renewables infrastructure, see NRGI's Gas-to-Power Framework Module 4, forthcoming 2024.) Additionally, solar and wind can make energy planning easier when future electricity demand is uncertain. Solar and onshore wind farms are usually smaller than large gas extraction projects and gas power plants. They are also easier to build piecemeal, in phases.

2. Uninterrupted energy supply

Changes in global energy demand or dynamics in foreign markets generally do not affect generation of solar and wind power.

Also, unlike gas reservoirs, the sun and wind are not exhaustible, fast-depleting resources. But power from renewable generation is intermittent and variable since solar irradiation and wind speeds fluctuate. Back-up gas power could help some countries manage this serious challenge, though they may have cheaper, more sustainable options. (For an overview of these, see NRGI's Gas-to-Power Framework Module 1.)

3. Lower energy sector costs

Fuel price is the biggest variable cost in operating gas power plants. For renewables, it is the upfront cost of building the infrastructure. Solar and wind farms have the great advantage of free fuel. The prices of components for them have also fallen dramatically—and are likely to fall further. Yet in many lower- and middle-income countries, investors charge utilities high premiums that drive up the costs of capital. This could make gas power the cheaper option in some places, at least for now. In Africa, for instance, the average cost of electricity from combined cycle gas turbines is still lower than for on-grid solar—though this could change by 2030. Overall, stakeholders need more country-specific data and analysis to predict the future costs of gas and renewable power in particular places. Governments, investors and development finance institutions like development banks and export credit agencies should do more to bring down upfront costs for renewables in lower- and middle-income countries, especially the high cost of capital.

4. Stable energy prices

Price dynamics in foreign markets affect the costs of solar and wind generation much less than they can with gas-fired power. There can be exceptions, such as when a country also produces electricity or green hydrogen for export, or supply chain issues make imported components more expensive. The sun and wind also will not run out, so once installations are built, utilities will not have to abruptly switch supply source, which often has price implications for gas (e.g., in from onshore to offshore gas, or from domestic gas production to imports).

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